TECHNICAL INFORMATION
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DEVELOPMENT OF 75-MM HIGH-EXPLOSIVE SHELL, T50 SERIES

The development of the T83 (now the M35) 75-mm gun, better known as a component of the Skysweeper weapon system, was begun in May 1947 to provide a more effective defense against the greatly improved aircraft expected to be in service in the near future. At the same time work was started on the development of the T50 HE shell for use in the T83. This shell, to be used with several types of fuzes, was to have an as-fired weight of 12.43 pounds with any of the various fuzes except the proximity fuze, in which case its weight would be 12.68 pounds. Its muzzle velocity was to be 2,800 fps. This new weapon system was planned as a replacement for the T22 75-mm gun firing the M48E2 HE shell.

At present there are four modifications of the T50 75-mm HE shell, three of which, the T50E2, the T50E8, and the T50E9, have been tested earlier in the course of development, and one, the T50E10, which has just recently been designed. The T50E2, adopted as standard (when filled with TNT) and designated the M334 in January 1956, and the T50E9 are identical in design except that the former uses a gilding-metal rotating band and the latter employs two sintered-iron rotating bands. Unlike conventional shell, which have either a square or boattail base, the T50E2 and T50E9 have hemispherical bases to which are welded covers that follow the contour of the base proper. The T50E8 has a square base and a gilding-metal band identical with that used on the T50E2. The T50E10, which also has a gilding-metal band, differs from the others only in that it has a truncated conical base. Each of these shell has a deep cavity and contains approximately 1.42 pounds of explosive and a 0.25-pound supplementary explosive charge, which is removed when a proximity fuze is used. All of the shell in the T50 series have relatively thin walls to provide for maximum fragmentation.

RELATED TIR'S

	TIR 6-5	Development of 75-mm Ammunition
10-56	TIR 6-5-1A1(2)	75-mm AP Shot, T149
10-56	TIR 6-5-8A2(2)	75-mm Chemical Shell, T262
1-55	TIR 6-5-8A3	75-mm Colored Marker HE Shell, T50E2
8-55	TIR 8-1-1B7	MTSQ Fuze, T286 Series
10-55	TIR 8-1-3A1	PD Fuze, T177E3
10-55	TIR 8-1-3B2	PDSD Fuze, T234 Series
____	TIR 8-1-7A13	Artillery Proximity Fuze, M516 (T73E12)

The T50E8 shell was designed to determine whether or not a square-base shell would be more stable than a hemispherical-base shell beyond 7,000 yards (this range was calculated as that at which both types are relatively equal in performance). Comparative testing of T50E2 and T50E8 shell at APG during the latter part of 1955 revealed that, although the T50E8 was slightly more stable and accurate and had a shorter time of flight, there was no significant difference between them. As a result, it was decided that a certain number of the remaining T50E8 shell would be used in terminal ballistic tests and that its production would be continued to provide test vehicles for fuze-recovery tests.

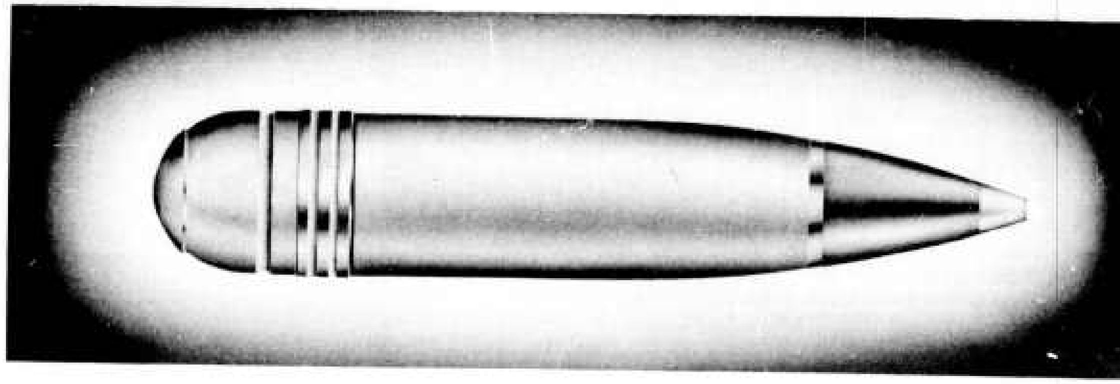
In the meantime, however, it had been considered advisable to adopt the Skysweeper weapon system and the T50E2 HE shell (with TNT filler) as standard. In October 1955, the Ordnance Technical Committee recommended that this be done, and in January 1956 the recommendation was approved, the T50E2 HE shell being designated the M334. In view of the fact that this weapon system was considered to be suitable only as an interim system, OCO informed Picatinny Arsenal in February 1956 that the project for the development of its ammunition should be brought to a conclusion. All work on the T50E8 shell was stopped shortly thereafter except for those steps necessary to collect and compile information concerning its development for inclusion in a technical report covering the over-all development of the T50 series. In October 1956, the project for the development of ammunition for the Skysweeper was officially terminated.

Just prior to the adoption of the T50E2 shell as the M334, tests were conducted at JPG with more than a thousand each of the T50E2 and T50E9 shell to determine whether gilding-metal or sintered-iron bands were the better. Based on the results of these tests, which were analyzed by representatives of JPG, APG, and Watertown Arsenal, it was agreed that sintered-iron bands were more satisfactory than gilding-metal bands for use with the T50 series of shell. It was decided, therefore, to conduct additional tests with Class 1 (low-density) and Class 2 (high-density) sintered-iron bands. Two hundred and twenty (110 of each type) were used in the assembly of T50E9 shell for test firing at JPG.

Analysis of these test results showed that low-density bands exhibited excessive chipping and that, in general, the use of high-density bands resulted in slightly higher velocity and pressure but did not result in any apparent increase in range although they made the shell slightly more accurate.

Meanwhile, OCO had informed Picatinny Arsenal that no additional work was to be done on the Skysweeper ammunition; consequently, no further tests were planned and all work was stopped except for those steps necessary to compile information on the development of sintered-iron bands for inclusion in the over-all technical report concerning the development of the T50 series.

At the time OCO informed Picatinny of its decision, the design of the T50E10 shell was also well under way. Instead of the hemispherical base of the T50E2, the T50E10 had a truncated conical base. This design, it was expected, would result in increased aerodynamic stability, because tests of the T91E2 90-mm HE shell, having the same



75-MM HE SHELL, T50E2

type of base, proved it to be more stable than the T91 model which had a hemispherical base. No T50E10 shell will be fabricated, however, because of the request that development of Skysweeper ammunition be brought to an orderly conclusion. A discussion of the development of this item will be included in the technical report covering the development of the T50 series of shell.

When the T50E2 (with TNT filler) was adopted as the M334 in January 1956, it was recommended that experiments be continued to determine the feasibility of using Composition B as a filler in place of TNT. The reason that Composition B filler was not adopted originally was because a number of premature bursts had occurred during early firings of shell filled with this high explosive. Additional tests showed, however, that these premature bursts occurred only in shell from one lot. Thirty-two shell from this lot and an equal number from a control lot were shipped to Watertown Arsenal for comparative studies of tensile strength and other metallurgical properties. Test results, made available in early 1956, showed that the lot that had contained shell bursting prematurely had greater tensile strength and microstructure than the control lot. Therefore, other factors had to be investigated before the cause of the premature bursts could be isolated.

To determine whether premature bursts were caused by cracks in the base of the shell, forty T50E2 shell were precooled at Frankford Arsenal and their base covers were attached by welds so as to induce such cracks. It was found that the shortest weld cycle that could be used was either a 10-second one without post annealing or a 5-second one with post-annealing. Twenty of the forty shell had base covers welded by using the former technique, and the base covers of the other twenty were welded by the latter method. Ten of each group were sectioned to determine which ones had the largest number of cracks. The remaining twenty shell were shipped to Watertown where the bases of each of the defective shell were subjected to a hydrostatic pressure of 100,000 psi, after which the shell were sectioned, microetched, and photographed. An examination of the ten shell whose

base covers were welded by the 10-second welding-cycle method showed that five of the shell had cracks in their bases. An analysis of photographs of specimens from these shell showed that none of the cracks extended beyond the heat-affected zone of the weld area. An equal number of shell prepared by the 5-second welding-cycle technique displayed similar cracks, but they were, in general, narrower and more shallow than the others. The tests conducted at Watertown Arsenal (18 out of the 20 shell shipped to that installation had cracks in their bases) resulted in no failures in the region of the base cover welds.

Additional work carried out to determine the cause of premature bursts was concerned with exudate-covered T50E2 shell and T50E2 shell with special cushioning devices to prevent the booster cup from detonating the explosive filler by means of setback.

In one group of tests, four-hundred T50E2 shell loaded with TNT and an equal number loaded with Composition B (both types of shell were fitted with dummy fuzes) were fired at JPG without a single premature burst, although small amounts of the filler had leaked out, lodged between the threads at the fuze, and covered some of the surface near the bourrelet. No additional tests of this type were planned, because of the action of OCO already referred to.

In another series of tests, firings were conducted with both TNT- and Composition B-loaded T50E2 shell fitted with M516 (T73E12) proximity fuzes. This fuze was used in initial tests because it was not designed to withstand firing stresses in the neighborhood of 50,000 psi. During these tests, premature bursts did occur, and it was determined that they were caused, not by the Composition B, but by the booster cup of the fuze, which, because of some inherent weakness, broke loose from the fuze and set back on the filler. Because of the large number of these fuzes in storage, however, it was not considered practical to substitute another fuze. Consequently, additional tests were conducted in an effort to find a way to use the M516 fuze with the T50E2 (Composition B) shell. For comparison, T50E2 shell with TNT filler were also fired. In the tests, conducted at APG during the latter part of 1955 and the early part of 1956, seven out of seven TNT-loaded shell assembled with M516 fuzes equipped with the defective booster cups resulted in premature bursts when fired at a chamber pressure of 50,000 psi. After fitting a stopcock grease-filled aluminum cup under the M516 fuzes, however, twenty shell were fired without a mishap. On the other hand, when Composition B shell were equipped with similar combinations of fuzes and cups, a premature burst occurred on the first firing. Even after lowering the chamber pressure to 45,000 psi, one premature burst occurred out of the two additional shell fired. Analysis of the test results indicated that the sidewalls of the aluminum cup were being pressed into the explosive charge with enough force to initiate the charge. In an attempt to prevent this from happening, a number of polyethylene bags filled with luting compound were manufactured and tested as substitutes for the aluminum cup, referred to above, for use in T50E2 (Composition B) shell employing M516 fuzes. During the firings, conducted at 112% of the rated chamber pressure, the fifteenth round resulted in a premature burst.

In additional tests, ten inert shell were fired for vertical re-

covery. Examination of the recovered shell revealed that the base segment of the M516 fuze in each of the eight shell that were recovered had crushed against the filler, and in some cases the sidewalls of the auxiliary detonator had been imbedded in the filler, either of which actions could have caused a premature burst.

As a result of these tests, it was decided that static tests of shell assembled with luting-compound pads of the order of thickness (0.166 inch) of those used in the previous tests would be conducted to determine whether or not such pads would prevent proper functioning of the M516 fuze under these test conditions. If the results of these tests showed that this thickness of inert material did not affect adversely the functioning of the fuze, it was planned to recommend the initiation of a large-scale test program to determine whether T50E2 (Composition B) shell with luting-compound pads and stronger M516 fuzes would result in premature bursts. However, no additional information is available as to whether any steps were taken to conduct the static tests, after OCO's decision in February 1956 to stop further development work on the Skysweeper ammunition.

The M334 (TNT-filled T50E2) 75-mm shell, which is now an item of issue, may use any of the following authorized fuzes: the T177E3 PD; T234 PDSD; M518 (T286E1) MTSQ; and the M516 (T73E12) proximity fuze. Two additional fuzes, the M51A5 PD and the M502A1 MTSQ, are authorized for combat emergency purposes only. By the same action of the Ordnance Technical Committee that adopted the M334 shell and authorized the fuzes for use with it, the T6E3 brass cartridge case was adopted as the M35, and the T6E3B1 steel cartridge case as the M35B1. An M58 percussion primer and 3.62 pounds of M6 propellant complete the assembly of the standard round.

Each shell in this series is designed to be assembled as a fixed round of ammunition and to be shipped without a fuze. In the final assembly the cartridge case is crimped to the shell in the conventional case-below-band method (some of the metal in the case being displaced by forcing it into a groove machined around the base of the shell), and the mouth is sealed by a threaded closing plug. Before firing, the plug is removed and replaced by a fuze of the type desired. The supplementary charge must be removed when a proximity fuze is used.

Additional work scheduled, as of June 1956, for this series of rounds included static tests of two lots of T101 primers to determine if there is any variance in primer functioning that would account for erratic ignition such as that experienced during tests at JPG during the latter half of 1955. Other firings were planned to determine whether M1A1 propellant using an ether-alcohol ratio of 2:1 will eliminate erratic ignition. As yet, no other information is available concerning these tests.

The following characteristics are for the M334 75-mm HE shell only.

TENTATIVE PRINCIPAL CHARACTERISTICS

Caliber	75 mm

Model of weapon in which used AA gun	M35 on M51 towed weapon system 75-mm AA gun
Type	fixed
Projectile	
Weight, as fired	12.43 lb
Length with fuze	14.62 in
Charge	TNT
Weight	1.42 lb
Charge, supplementary	TNT
Weight	0.25 lb
Stabilization	spin
Fuzes	T177E3 PD, T234 PDSD, M518 MTSQ, M516 proximity, M51A5 PD, M502A1 MTSQ
Cartridge case	M35 or M35B1
Length	21.3 in
Weight	5.28 lb
Propellant	M6
Weight	3.62 lb
Primer	M58
Length of complete round	33.55 in
Weight of complete round	21.56 lb (approx)
Performance	
Maximum horizontal range	15,000 yd
Maximum vertical range	18,000 ft
Muzzle velocity	2,825 fps